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THE IMPACT OF TRADE POLICIES ON THE DEMAND FOR AND REVENUE FROM U.S. FEED GRAINS

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In recent years agricultural exports have made a major contribution to the improvement of the U.S. balance of payments. Increases in feed grain (corn, grain sorghum, oats, barley, and rye) exports were a major factor. Trade policies of exporters and importers of feed grains have changed during the last two decades; and, these changes, reflected in the programs of individual countries and in agreements and contracts negotiated between pairs of countries, have affected the export sales of U.S. feed grains and the total revenue of U.S. feed grain producers.

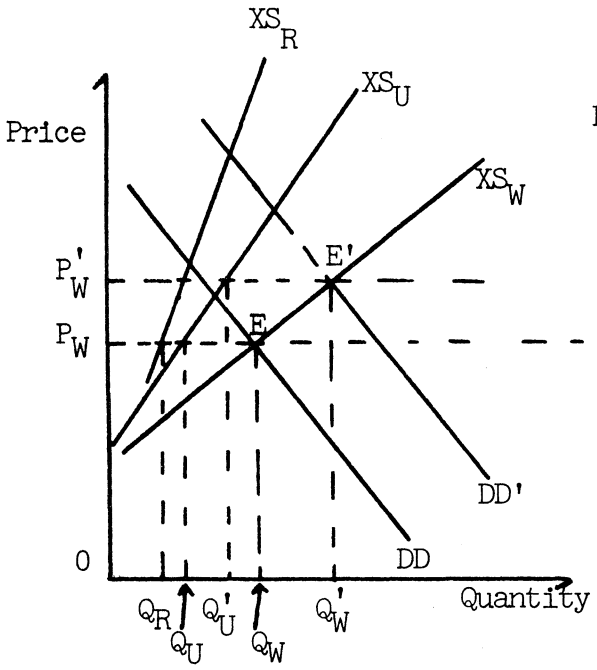
The objective of this paper is to examine the effects of selected trade policies on sales of and revenue from U.S. feed grain production. The selected policies are tariffs, minimum import prices, export subsidies, and import and export quota restrictions.

The Analytical Framework

A change in any feed grain trade policy will affect directly the world market and the U.S. export market for feed grains and, indirectly, the U.S. domestic market for feed grains. Relationships among the prices and quantities in these three markets are illustrated in figures 1.a, 1.b, and 1.c.

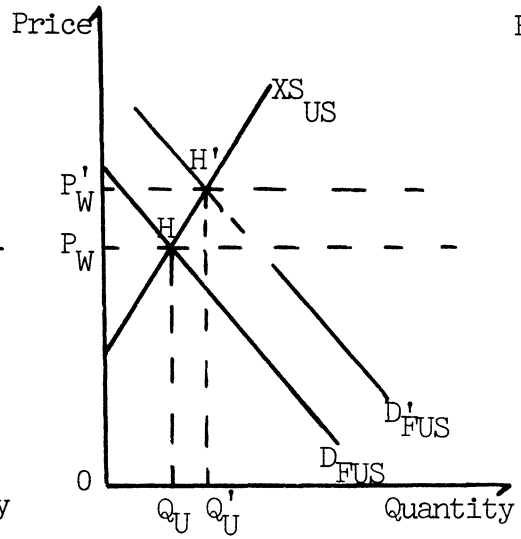
The equilibrium world price is determined in the world market (fig 1.a). The excess supply curve (XS_W) for the world is the summation of the excess supply curves (XS_U and XS_R) for the United States and for the rest of the world (R) exporters, respectively. The demand by the importing countries is DD. Equilibrium world price is P_W and exports from the U.S. and R are OQ_U and OQ_R, respectively. Under conditions of free

Figure 1: Relationship among World, U.S. Foreign, and U.S. Domestic Markets



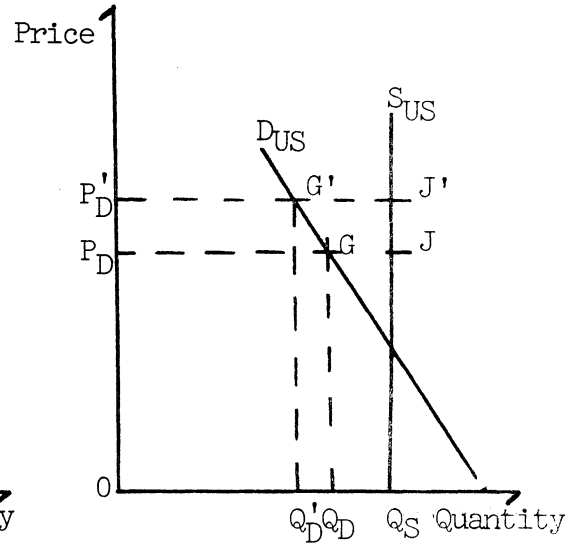
World Market

Figure 1.a



U.S. Foreign Market

Figure 1.b



U.S. Domestic Market

Figure 1.c

trade and zero transportation costs[2/], the feed grain price (P_D) in the domestic market is the same as the world price. The quantity consumed domestically is OQ_D and the quantity supplied (produced) is OQ_S, while $Q_D Q_S (=OQ_u)$ is the amount exported.

Changes in the world excess demand and/or excess supply functions will affect the quantity of feed grains demanded in both the U.S. domestic and the U.S. export markets. A decrease in an importing country's tariff of feed grains can be represented by an upward shift in the world's demand function, DD' in fig. 1.a. This results in an increase in world price to P'_W and in the exports (OQ'_U and OQ'_R) of the U.S. and R, respectively. The U.S. export demand, fig. 1.b, shifts upward to D'_{FUS} and U.S. exports increase by $Q_U Q'_U$. Domestic consumption decreases by $Q'_D Q_D$. Since the slope of XS_U, fig. 1.b, is equal to the negative of the slope of D_{US}, it follows that for export increase ($Q_U Q'_U$) to equal domestic consumption decrease ($Q'_D Q_D$), the change in world price ($P_W P'_W$) must equal the change in domestic price ($P_D P'_D$). This assumes instantaneous adjustment from one equilibrium to another. Thus, the total revenue from U.S. feed grain sales in both markets is affected by the tariff decrease. That is, initially, the total revenue is $OP_W HQ_U + OP_D GQ_D = OP_D JQ_S$. After the tariff decrease, total revenue will increase to $OP'_W H'Q'_U + OP'_D G'Q'_D = OP'_D J'Q_S$. However, with this change revenue from the domestic market may increase, decrease, or remain the same dependent upon the elasticity of the demand for feed grains in the domestic market.

The effects on revenue as a result of changes in other trade policies can be analyzed similarly using this analytical framework.

In figure 1.c, the supply schedule was indicated to be perfectly inelastic, a characteristic of the very short-run supply situation. In the longer run, the feed grain supply schedule would be less than perfectly inelastic. Under this condition, the excess supply curve (XS_U) for the U.S. would be changed. Its slope would then be the difference between the slopes of D_{US} and S_{US}. The analysis of the effect of a tariff decrease remains unchanged. However, the increase in exports would be offset by a decrease in domestic consumption plus an increase in total quantities supplied by U.S. feed grain producers.

Estimation of the Export Demand Function

In order to estimate the impact of changes in selected trade policies on the U.S. feed grain market, the U.S. export demand function and the elasticities of domestic demand for and supply of feed grains must be known. The export demand function was derived from: 1) the feed grain import demand functions of major importers of U.S. feed grains, and 2) a set of demand share functions.[3/] Import demand functions and U.S. demand share functions were estimated for each of four major importers: Japan, Italy, West Germany, and United Kingdom.[4/]

The variables included in the import demand function (quantity dependent) for each importer were: 1) import price, 2) level of income or level of meat production, 3) amount of feed grains produced domestically, 4) and a proxy for change in trade policy, if appropriate. Ordinary least squares methods were used to fit these functions to 18 years (1955-1972) of data. The R^2 coefficients ranged from .45 to .96. The derived

elasticities of import demand are given in table 1.

TABLE 1

U.S. Feed Grain Export Demand Elasticities, Major Importers

Country	Total Import Demand Elasticity[a]	U.S. Demand Share Elasticity[a]	U.S. Export Demand Elasticity[a]
Japan	-0.3897	-2.6703	-3.0600
United Kingdom	-1.1845	-1.7758	-2.9603
Italy	-3.2576	-8.1448	-11.4024
West Germany	-0.5583	-1.4179	-1.9762

[a]Elasticities are computed at the mean values of quantity imported and price for 1955-1972.

Source: Computed.

The determinants of U.S. export demand share by each importer were: 1) U.S. feed grain price in the importing country, 2) the corresponding price of competing exporters, and 3) a proxy for any change in trade policy. OLS methods were used to fit these functions to the 18 years of data, except for West Germany for which only the most recent 14 years were used. R^2 ranged from .25 to .82. The estimated U.S. demand share elasticities are given in table 1.

From these two sets of elasticities are derived the U.S. export demand elasticities for each of the importing countries.[5/] The derived elasticities are given in the last column of table 1. Using a weighted average of these

4 U.S. export demand elasticities, the total U.S. export demand elasticity was estimated to be -4.26 for time period 1963-72, -4.17 for 1968-72, and -4.03 for the most recent years (1970-72).

While the statistical precision of these results leaves room for improvement, there is sufficient accuracy to make the results usable for this analysis.

Domestic Supply and Demand Elasticities

Knowledge of the domestic supply and demand elasticities for U.S. feed grains also is required for determination of the effects of trade policy changes. Ahalt and Egbert (1965) estimated the domestic demand elasticity to be -.264, based upon 1948-63 data. This is nearly identical to the Brandow (1961) estimate of -.265 for low protein feeds. The domestic demand elasticity of -.265 was accepted as the relevant one. To allow for recent possible changes in this elasticity policy effects were also computed for a domestic demand elasticities of -0.22 and -0.32.

Domestic supply elasticities for feed grains are taken from Ryan and Abel (1972, 1973a, 1973b). Acreage response elasticities were estimated for corn, for sorghum, for oats, and for barley.[6/] The elasticity of supply of U.S. feed grains was formed as the weighted average of the elasticities for each crop, where production was the weight. The estimated supply elasticity for each of 3 time periods is:

Time Period	U.S. Supply Elasticity
average 1963-72	0.1569
average 1968-72	0.1649
average 1970-72	0.1545

Combining the selected values of the domestic supply and domestic demand elasticities, the elasticity of the excess supply curve (XS_U) for the U.S. is determined. These excess supply elasticities for the different domestic elasticities are given in table 2.

TABLE 2

Elasticity of Excess Supply, U.S.

Elasticity of Domestic Demand	Elasticity of Domestic Supply		
	ave. 1963-72	ave. 1968-72	ave. 1970-72
	0.1569	0.1649	0.1545
-0.22	0.3769	0.3849	0.3745
-0.265	0.4219	0.4299	0.4195
-0.32	0.4769	0.4849	0.4745

Source: Computed

Effects of Selected Trade Policy

Using the model described in the analytical framework and the empirical estimates of elasticities of U.S. export demand (table 1) and of U.S. excess supply (table 2), the effects of changes in trade policy can be determined.

As an example, using a Japanese tariff reduction equal to 10 percent of world feed grain price, the detail of calculation will be given. For remaining policy changes, only the outcome is presented.

Let Japan reduce its tariff by 10 percent of world feed grain price. This is equivalent to an upward shift in the Japanese and, therefore, the world demand curve for feed grains. Using the elasticity of total import demand for Japan (table 1), the quantity demanded of feed grains would be increased by 3.897 percent.[7/] This change shifts D_{FUS}, the foreign demand for U.S. feed grains upward. The change will also cause a world price higher than P_W. The overall effect of these changes is to increase exports to Japan by 0.23 percent. The change in US price associated with this change in exports is computed using the elasticities of U.S. excess supply, table 2. For the supply base period (1963-72) and an elasticity of domestic demand of -0.22, an increase of 0.3769 percent in quantity supplied is associated with a 1 percent increase in world (or domestic) price. These price changes can then be used to determine changes in domestic supply and consumption, as well as changes in revenue obtained from sales of feed grain in both the deomestic and foreign markets.

A Summary of Effects

A 10 percent increase in price due to an imposition of tariff by all importers results in a 6.56 to 7.56 percent ($531.1 to $672.0 million) decrease in total revenue of U.S. feed grain producers and a 2.69 to 3.29 percent (0.62 to 0.87 million metric ton) decrease in quantity of feed grains exported by the U.S. The specific value of these effects depends on time period selected, the value of elasticity of domestic demand, and the importing country. A tariff reduction equivalent to 10 percent of price will lead to similar numerical results, but in the opposite direction.

A $5 reduction in minimum-import-price requirement in the United Kingdom corresponds to a 0.42 to 0.50 percent ($36.8 to $40.2 million) increase in total revenue for U.S. feed grain producers, and a 0.16 to 0.23 percent (0.04-0.05 million metric ton) increase in quantity of feed grains exported by the U.S.

A U.S. export subsidy increase equal to 10 percent of price leads to a 0.32 to 0.50 percent ($27.8 to $38.6 million) increase in total revenue of U.S. feed grain producers, and a 3.43 to 4.34 percent (0.78 to 1.17 million metric ton) increase in quantity exported of U.S. feed grains. But, using a feed grain price of $65 per ton, the subsidy would require at least $146 million from the public treasury. So there is considerable ($127 million) loss.

Similarly, a 1 percent increase in export subsidies of the competing exporters implies a 0.90-1.02 percent ($78.6 to $87.9 million) decrease in U.S. sales of feed grains and a 0.37 to 0.48 percent (0.08 to 0.13 million metric ton) decrease in quantity of feed grains exported by the U.S.

A 10 percent decrease in import quota (imports restricted to 90 percent of those previous) by Japan results in a 0.38-0.47 percent ($29.7 to $43.7 million) decrease in total revenue for U.S. feed grain producers and a 0.15-0.22 percent (0.03 to 0.06 million metric ton) decrease in quantity of feed grains exported by the U.S.

If the U.S. restricts exports to 90 percent of unrestricted equilibrium exports, the total revenue for U.S. producers decreases between 4.09 and 6.81 percent ($325.9 to $644.1 million) and the quantity exported of U.S. feed grains decreases by 10 percent (2.25 to 2.77 million metric ton).

Similar effects on revenue from U.S. feed grains can be obtained from different policies implemented at different levels. Using the base period of 1963-1972, and the elasticity of domestic demand of -0.265, it is shown that for Japan, the effect on U.S. feed grain revenue of a tariff increase equal to 10 percent of price is equal to that of a reduction in imports by 6.5 percent. The results also demonstrate that a 1 percent decrease in U.S. export subsidies has the same effect on revenue as a 0.6 percent decrease in U.S. export quota. Another example shows that a $5 reduction in threshold price for West Germany corresponds to a 2.38 percent increase in import quota from previous level of imports of U.S. feed grains. Other combinations of trade policies can be compared using the same procedure. The results will depend on the base period used, the values of the U.S. domestic demand elasticity, and the individual country.

Footnotes

1/ Francis Walker is Professor of Agricultural Economics, Ohio State University and Kleo-Thong Hetrakul is Economist, Bank of Thailand.

2/ The introduction of positive transportation costs of a constant per unit amount would shift the excess supply curves up and to the left. However, the analysis remains basically unchanged.

3/ The method is similar to that used by Saylor and French (1974), Sirhan and Johnson (1971), and Cowling and Rayner (1970) following the work of Telser (1962).

4/ Initially, Netherlands and Belguim - Luxembourg were included in the study. However, attempts to estimate the functions for these countries yielded unsatisfactory, and essentially unusable, results. The remaining 4 importing countries accounted for more than 50% of imports of feed grain during the time period of the study.

5/ The derivation of the U.S. export demand elasticities from the import demand and U.S. demand share elasticities is given in detail in Hetrakul (1975) and follows the method of Telser (1962).

6/ While other estimates are available, these were selected because: 1) the estimates were obtained using the same methodology, and 2) since the work was done by the same researchers, it is felt the results will bear a greater amount of internal consistency.

7/ In equilibrium, before and after a non-preferential tariff change, $P_W=P_{US}=P_R$; that is, $\frac{P_{US}}{P_R} = 1$ Therefore, with no change in relative prices for US and R, there will be no change in U.S. export shares. Consequently, the U.S. export demand elasticity is equal to the elasticity of total import demand of the importing country.

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